Asparagus CULTURE

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Cover Illustration.—Asparagus spear being cut for market.

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Asparagus Culture

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Asparagus is one of the most valuable of the early vegetables and perhaps the most important of the perennial vegetable crops. It is healthful and palatable as a canned or a frozen product and as a fresh vegetable. The importance of asparagus as a vegetable is evidenced by the large acreage being used for its production both as a home- and market-garden crop.

The total acreage devoted to the commercial production of asparagus remained nearly constant during the 10 years, 1942–51. However, during this period there was a gradual reduction in the acreage planted to asparagus for fresh consumption and an increase in the acreage grown for processing. According to the Agricultural Marketing Service, United States Department of Agriculture, a total of 133,510 acres was harvested in 1942. Of this total, 58,880 acres were harvested for the fresh market and 74,630 acres were harvested for canning and freezing. By 1951 the acreage for fresh-market asparagus had dropped to 37,150 while that for processed asparagus had risen to 93,450, for a total of 130,600 acres. Advances in freezing and handling processes have undoubtedly been major factors in the shift from fresh-market to processed asparagus.

During the period 1942–51 the States important in producing asparagus for fresh consumption were California, New Jersey, Washington, Pennsylvania, Illinois, South Carolina, Maryland, Massachusetts, and Michigan. All of these States except South Carolina, Pennsylvania, and Massachusetts were also important producers of asparagus for processing. Delaware and Iowa also ranked high in the production of processed asparagus. California was by far the largest producer of both types of asparagus.

Climatic and Soil Requirements

Asparagus is found growing wild in many places where the seed has been scattered by wind, water, birds, and other carriers. The plant is grown in home gardens in nearly all sections of the country, but conditions for commercial production are limited. Asparagus is a native of temperate regions and cultivation is most successful where either low temperatures or drought stops growth of the plant and gives it a rest period.

Commercial asparagus culture should not be undertaken where conditions are such that the plant continues to grow throughout the year. Important chemical changes that greatly influence the future development of the plant take place in the reserve food supply during the resting stage, and if the plant does not have a rest period the shoots may become less vigorous and more spindling each year.

Yields in Southern States are often only ⅓ to ½ as great as yields in Northern States. Nutrition, cultural practices, and other factors no doubt contribute to these differences; but it is believed the lack of severe winter temperatures in the South is partly responsible. In some sections having mild winter temperatures and low rainfall the required rest period can be induced by drought. In the lower Sacramento Valley of California, for example, asparagus is given its rest period by withholding irrigation water.

Asparagus can be grown on many kinds of soil, but good drainage is essential. The asparagus plant has an extensive root system and for maximum development must have an open, porous soil. The best types of soil for permanent plantations are deep, loose, and light—mucks and light sandy loams, for example. Since early-spring growth depends on the reserve food in the fleshy roots, a soil that allows full development of the storage roots, which may reach a length of more than 10 feet, should be provided. Where earliness is important, a soil that warms up readily in the spring is essential, for temperature is an important factor in early growth.

Very light sandy or gravelly soils having a porous subsoil should be avoided. The moisture-holding capacity of such soils is too low for profitable asparagus production. Soils having a gravelly or hardpan subsoil are not desirable either. Many of the commercial asparagus soils of the South have a light sandy topsoil underlain by clay. Heavy soils are not the best, but may be satisfactory for asparagus if they are not so heavy that they bake. Heavy soils are more difficult to work, and they warm up slowly. Muck and light sandy loams well supplied with organic matter are ideal for asparagus.

Asparagus is found growing naturally on the banks of streams and near salt marshes, where the salt content of the soil is high and the reaction somewhat alkaline. It does well in moist places, if the water table does not come within 4 feet of the surface.

Asparagus will thrive in soils having a salt content too high for many other crop plants but will not tolerate extreme acidity. Soils ranging from slightly acid to slightly alkaline are best for asparagus. Land known to be very acid should have an application of lime to make the reaction nearly neutral before being planted to asparagus. The tolerance of the asparagus plant to various salts makes it possible to utilize for its production land that is too alkaline for some other crops. However, the yields are likely to be lower and the life of the planting shorter on such land than on land more nearly neutral in reaction.

Fertilizing Before Planting

The long time that the land is occupied by an asparagus plantation makes it highly desirable that the soil be made fertile and be put into the best physical condition possible before the plants are set. The question of fertilizer practice is a local problem and must be determined largely by local conditions. What has proved to be a good practice in one locality may not be good where soil and climatic conditions are different. Furthermore, a fertilizer that gives the greatest yield may not return the greatest profit per acre, for the cost of the fertilizer may be proportionately more than the increase in yield. This is especially true if high-priced manure is used.

Asparagus thrives best in a soil well supplied with humus. In soils of mineral origin the application of some organic material may be more important than the addition of nitrogen, phosphorus, and potassium. Soils of organic origin like peat and muck, already well supplied with humus, may need only the addition of one or more of the fertilizing elements to put them in a good state of fertility. Some organic soils need no fertilizer before planting. In one of the large production areas in California, trials on highly organic soil indicated no response of asparagus to any kind of fertilizer regardless of time or rate of application.

Where organic matter is needed it can best be supplied in the form of animal manure, if this can be obtained at a reasonable cost. Animal manures are especially desirable because they add some plant food and also improve the physical condition of the soil by the addition of humus. The present cost of animal manure makes it inadvisable, however, to try to maintain fertility on large plantations by the use of it alone. It is a good practice to supply part of the required materials in the form of manure and part by commercial fertilizer.

Where animal manure is not available at low cost, the required organic material can be supplied by turning under a green crop. Some of the leguminous crops, such as cowpeas, soybeans, vetch, or clover, are preferable, as they add some nitrogen to the soil if they are properly inoculated with nitrogen-fixing bacteria. Where it is impractical to grow a legume, one of the small-grain crops such as rye, wheat, oats, or barley can be used. Although the grains do not add nitrogen to the soil as do the legumes, they furnish a quantity of organic material and should be used where legumes cannot be grown to advantage.

In turning under any manure crop attention should be given to its effect on the nitrogen supply in the soil. This applies also when large amounts of coarse, strawy stable manure are used. Such manures, high in woody materials, require large amounts of nitrogen in their decomposition. If these woody materials have not decayed before the planting of a crop, they may cause nitrate starvation. To help keep a supply of nitrogen available it is a good practice to apply 100 to 300 pounds per acre of a high-nitrogen fertilizer, such as nitrate of soda, or sulfate of ammonia, to aid in the decomposition process. Green-manure crops, especially legumes, turned under while green and succulent decompose more rapidly than woody material and are less likely to cause nitrogen starvation during decomposition.

Green manure or a heavy application of animal manure should be turned under the season before the asparagus crowns are set. A light application of well-decomposed manure may be broadcast and worked into the surface soil. If only a limited supply of manure is available, it can be utilized more economically by placing it in the bottom of the planting furrow than by broadcasting it. When thus applied, the manure should be well rotted and thoroughly incorporated in the soil before the crowns are set. As already noted, use of some commercial fertilizer in addition to manure is usually advisable. In general, the longer the land has been in cultivation the greater is the need for one or more of the fertilizing elements. Soils in the eastern part of the country are more likely to require commercial fertilizer than western soils. An application of 1,000 to 2,000 pounds

per acre of a complete fertilizer containing 6 to 8 percent of nitrogen, 10 to 15 percent of phosphoric acid, and 6 to 10 percent of potash is often profitable. If applied before the plants are set, the fertilizer should be broadcast and thoroughly mixed with the soil. The application of part of the commercial fertilizer may be delayed until after the crowns are set. This part should be applied along the rows and worked into the soil by cultivation.

If a legume rather than a nonlegume is turned under as a greenmanure crop, less nitrogen will be required in the commercial fertilizer. Animal manures vary greatly in the percentage of the fertilizing elements they carry. Furthermore, soil origin and climatic conditions influence soil fertility and fertilizer requirements. Such variable factors as these prevent the establishing of a fertilizer practice which would be best under all conditions.

Maintaining Fertility

Except in areas where trials indicate no need for fertilizer, asparagus plantations should be fertilized every year. The first season or two after the asparagus is set, 1,000 to 1,500 pounds of a complete fertilizer should be broadcast and worked into the soil as early in the spring as the soil can be handled. This should be followed by one or two applications of nitrate of soda or other readily available nitrogen fertilizer along the rows at the rate of 150 to 200 pounds per acre.

There is no general agreement on what is the best time of the season to apply fertilizer to beds ready for harvesting. A common practice, however, is to apply part of the fertilizer just after the cutting season, because asparagus draws most heavily upon the plant food when it is making top growth and storing reserve food in the fleshy roots. Investigations by the New Jersey Agricultural Experiment Station show that the asparagus plant can utilize nitrates in the spring and during the cutting season. The records of yields for 9 years at the Maryland Agricultural Experiment Station show no consistent difference in the yield of asparagus fertilized at the beginning and that fertilized at the end of each cutting season. More recent investigations by the South Carolina Agricultural Experiment Station indicate that certain fertilizers, such as 10–8–5 and 5–8–5, when used at the rate of 2,000 pounds per acre give the greatest yields when half is applied before harvest and half after harvest, with a later application of about 150 pounds of nitrate of soda.

Some successful growers apply quick-acting nitrogen fertilizer early in the spring and sidedress the rows during the harvesting season. They believe that early applications of such nitrates help to maintain production and quality, especially where green asparagus is grown. Other equally successful growers apply most of the fertilizer at the end of the cutting season because they believe that the asparagus plant can make more efficient use of it while making top growth and storing reserve food in its roots.

Local conditions should be considered in determining the time to apply fertilizer and the quantity of fertilizer to be applied to a producing field. For example, it is better not to make a heavy application of fertilizer during a period when the soil moisture is likely to be low for some time, as it often is at the end of the cutting season in some nonirrigated sections. With

low moisture the plant may not be able to make use of the fertilizer, and in extreme cases injury may result. Under such conditions heavy applications of fertilizer are best made in early spring, when soil moisture is usually more abundant.

It is a good practice to divide the fertilizer used, applying part of it before growth starts in the spring and the remainder at the end of the cutting season. In most cases a balanced fertilizer carrying all three of the important elements—nitrogen, phosphorus, and potassium—is best. Where a soil is known to be already high in one or more of these elements a fertilizer should be used that meets the particular needs. Mixed fertilizers carrying 4 to 6 percent of nitrogen, 8 to 12 percent of phosphorus, and 6 to 10 percent of potassium are in general use. The 5–8–7 and 5–10–5 fertilizers are widely used. Besides the general fertilizer application it is sometimes necessary to use one or two side dressings of a quickly available form of nitrogen such as nitrate of soda or sulfate of ammonia. One application of 200 to 300 pounds or two applications of 150 pounds each are sometimes necessary, especially after periods of prolonged heavy rains, which leach nitrogen from the soil.

Since asparagus thrives best on nearly neutral soils, attention should be given to soil reaction in applying fertilizers. If acid fertilizers are used in large amounts it is necessary to adjust the soil reaction with lime. Asparagus is a heavy feeder on calcium, and many eastern soils require regular applications of lime to maintain the calcium content and proper soil reaction. As much as 1,000 to 2,000 pounds of limestone may be required annually for a period of years until the calcium content becomes fairly high. Many eastern soils are also low in magnesium. Where this element is low a dolomitic lime high in magnesium should be used.

The use of common salt, or sodium chloride, was at one time considered essential for asparagus production. It has been shown that sodium chloride and sodium carbonate may be beneficial on soils low in potassium. Where the potassium content is high or where fertilizers relatively high in potassium are applied, the addition of sodium salts has produced little response. The same stimulation as that obtained from sodium salts can no doubt be more efficiently obtained from potassium. The best growers obtain satisfactory yields without sodium salts, and their use is not generally advisable.

In some of the eastern asparagus districts cowpeas and soybeans are being grown as a late cover crop with good results. The seed of the cover crop is drilled in between the asparagus rows about 3 weeks after the cutting season, about 5 pecks of seed being used per acre. The cover crop tends to prevent weed growth and, if the growth is disked in, adds considerable organic matter as well as some nitrogen to the soil. This is a good practice and one likely to become more general with the increasing scarcity of animal manure.

Varieties

There are only a few varieties of asparagus, and the varietal differences between some of these are not well defined. Male and female flowers are borne on different plants, and this results in a constant mixing of strains in the field which makes it difficult to obtain seed that will produce plants uniform in type and true to varietal characteristics. Since the crowns

are propagated almost wholly from seed, wide variation may appear in any lot of crowns unless special effort is made to isolate the seed-producing plants from the pollen-producers. Where more than one variety is grown for seed, careless handling of seed stocks soon results in mixture and in less distinct varietal differences.

Because of these facts and the fact that the bed or field to be planted will last for many years, the importance of care in selecting planting stock is apparent.

Asparagus varieties are of two general types based on the color of the spears. The more important group includes the varieties Mary Washington, Martha Washington, Reading Giant, Palmetto, and Argenteuil. Spears of this group become dark green in sunlight. The less important group includes such varieties as Conover's Colossal and Mammoth White. These produce light-green or whitish spears. These light-colored varieties should not be confused with white (blanched) asparagus as grown for canning. The whiteness required for the white canned spears is produced by covering the crowns of either the light-green or dark-green varieties with a ridge of soil several inches deep. The blanched spears are cut just as they break through the soil and before they are exposed to sunlight.

The older, light-green varieties—Conover's Colossal and Mammoth White—and the dark-green variety, Palmetto, have been largely replaced by the more rust-resistant Mary Washington and Martha Washington varieties. Reading Giant and Argenteuil are also being replaced by the Washington varieties.

Besides having rust resistance, the Washington varieties are of high commercial quality, fully equal or superior to the best other varieties on the market in earliness, vigor of growth, and size and quality of shoot. They are also more uniform in size, shape, and color than the old standard varieties and are very productive of large spears. The Martha Washington variety is more rust resistant, but the Mary Washington variety is slightly earlier, more vigorous, and is resistant enough to make it more popular for general planting.

Three new selections from the Washington varieties have been introduced. These are Paradise, Mary Washington 500, and Mary Washington 499. These are all reported to be rust resistant.

In establishing a new plantation it is important to use one of the rust-resistant varieties, especially in localities subject to rust epidemics. In fact, many nurserymen and plant growers now list only the varieties resistant to asparagus rust. More information on rust is given later in this bulletin in the section on asparagus diseases.

Growing and Handling the Crowns

For the home garden or a small planting it is perhaps best to buy 1-year-old crowns from a reliable nurseryman, but where a large acreage is to be planted it may be advisable for the grower to raise his own plants. The advantages in growing crowns rather than purchasing them are: (1) the grower can select his own source of seed; (2) it usually costs less to grow large quantities of crowns than to buy them; (3) special care can be exercised to produce large healthy crowns; (4) selection can be practiced and only the best crowns transplanted; (5) the crowns can

be transplanted with less injury from exposure and drying.

The first essential in growing crowns is to obtain good seed of the desired variety. The crossing that occurs in the field, as already mentioned, adds greatly to the difficulty of procuring seed of known quality for planting. Unless special care is exercised in the selection and handling of both the seed-bearing and the pollen-bearing plants, the seedlings may be somewhat variable. Most asparagus varieties are rather variable at best; hence the great importance of good seed of known quality.

Seed capable of producing high-yielding crowns can be obtained only by the selection of high-yielding parents. High-yielding male and female plants should be selected and isolated in such a way that the selected female plants receive pollen only from the selected males, and not from other sources. Seed obtained from parents selected and protected in this way should produce crowns capable of a much higher average yield than seed from unprotected field-grown parents. The importance of good seed from high-yielding parents cannot be too strongly emphasized for a perennial crop like asparagus. Even a small difference in yield per crown resulting from careful selection of seed stock may mean great difference in profit over the lifetime of the planting.

Close attention must be given the seedbed if good results are to be obtained. The soil should be worked until it is free from clods, for germination is likely to be poor in a rough, cloddy soil. A finely pulverized, well-prepared seedbed permits the soil particles to come into close contact with the seed, insuring constant moisture supply and thereby hastening germination.

Asparagus seed is slow to germinate; it often requires 4 to 6 weeks for the plants to appear above ground, depending on soil temperature, moisture, and depth of covering. Asparagus seed absorbs water slowly at temperatures below 70° F. and if dry seed is planted in cold soil several weeks may be required for the seedlings to appear. Germination of asparagus seed can be hastened by soaking the seed in water, but seed so treated must be handled properly or more loss than gain may result. It is recommended that seed be soaked at a temperature of 85° to 90° for 4 or 5 days. Little benefit is derived from a temperature below 75° or from a short soaking. After being soaked, the seed must be dried off and planted at once. Damp seed should not be held in containers from which air is excluded, and should not be held long enough after being soaked for decay organisms to develop on the seed. For best results soaked seed should be planted in moist soil; if it is planted in dry soil the benefit of soaking is lost.

For asparagus seedlings to have as long a season as possible to develop large crowns, the seed should be planted as early in the spring as the soil becomes warm enough for germination. In the Imperial Valley of California the seed is often planted late in January or early in February. In the North seeding is frequently done late in May. The best temperature for the germination of asparagus seed is between 75° and 85° F. Below 70° germination is very slow.

If the germination is known to be good it is advisable to plant the seed thinly. It is better to allow the plants enough space at seeding time than to attempt to thin them. Thinning is difficult, and the crowns are hard to separate after digging if they are grown so close together

that the roots are interwoven. Moreover, thin seeding saves expense and reduces root injury in separating the crowns. The best spacing can be obtained by planting with a mechanical seeder, which can be adjusted to drop a single seed at regular intervals.

In growing asparagus crowns for field planting it is good practice to plant the seed in rows 24 to 30 inches apart and to drop 10 to 12 seeds per foot of row. The distance required between rows depends largely on whether the cultivation is to be done by hand or by horse- or tractor-drawn implements.

The quantity of seed used for growing enough crowns to plant an acre ranges from 1 to 10 pounds. At the planting distances suggested, 1 to 2 pounds of seed should be enough. Many growers use too much seed.

The depth to plant depends upon the type of soil and the moisture conditions. The heavier the soil the shallower the seed should be covered. The chief object in covering seed is to provide proper moisture for germination. The question of uniform moisture during the germination period should be borne in mind in determining the proper depth to cover the seed. In light peat the seed may have a 3-inch cover; in sandy loam 1½ inches is enough, provided the soil is sufficiently moist for germination.

Weeds should be kept down, as they draw heavily on needed soil moisture. Cultivation should be shallow, especially late in the season, to prevent injury to the developing roots.

Before the crowns are dug, the old tops should be cut and removed so as not to interfere with the digging. A common moldboard plow or a special implement equipped with a U-shaped knife can be used to lift the plants from the nursery row. In digging the crowns care should be exercised to avoid injuring the roots. If the plants are lifted without injuring the tips of the fleshy roots, the roots will continue to elongate after being transplanted. Since the fleshy roots are essentially storage organs, it is important that their development be checked as little as possible.

It is best to set the crowns as soon as possible after they are dug. Where it is necessary to keep the crowns for a period before setting them out, they should be stored in some dry, protected place at a temperature near 40° F. Crowns should not be stored in pits, as they may be injured by becoming heated. Extreme drying of the crowns should be avoided. Experiments conducted in California, in which the yields from dried crowns were compared with those from crowns not dried, show the yields to be greatly reduced by drying. The greatest reduction occurred during the first cutting season, but the injurious effect of drying the roots was still apparent the second season.

Starting the Plantation

Local climatic conditions must be considered in determining the best time to plant crowns. In most sections of the country asparagus crowns are set as early in the spring as the soil can be worked. In some parts of the South and in the Delta and Imperial Valley districts of California, where climatic conditions are favorable, the roots are set late in the fall or during the winter. Fall and winter planting is necessary in some districts, as heavy rains may interfere with spring planting. Spring planting is preferred in the North because fall-planted roots may be injured by cold before they become established.

Age, Size, and Sex of Crowns

One-year-old crowns are the most desirable for setting. Under some conditions the grower may be justified in planting 2-year-old crowns, but crowns more than 2 years old should never be used. Divisions of old crowns are entirely unsuited for setting a new bed. Two-year-old crowns should not be used unless they have had space enough in the nursery row for proper development; even then the 1-year-old roots are preferable because they result in more productive plantations. Where the crowns are grown very close together, the fleshy roots may be injured in separating the crowns and severe root injury will materially reduce the yield in years following.

It is profitable to grade asparagus crowns on the basis of size and vigor, and to keep only the largest and best developed roots for planting. All small, weak crowns and those having many small buds should be discarded, as they tend to produce a high percentage of unsalable spears. A desirable root for planting is one having a large, well-developed root system with large buds well distributed over the crown.

Female plants produce larger spears than male plants, but male plants produce a greater number of spears having a greater total weight. The difference is so small that it seems advisable for the grower to pay particular attention to the selection of large, vigorous 1-year-old roots and leave the matter of sex to chance. Sex cannot be determined in most plants until the second year of growth, and 2-year-old crowns are definitely less desirable for planting than crowns 1 year old.

Soil Preparation

The soil in which asparagus crowns are to be set should be plowed deep and worked down by thorough disking. Furrows for the crowns can be opened with a lister or some other suitable implement (fig. 1), the depth of the furrow depending on the soil type. A deeper furrow is required in loose soil than in heavy soil, because the crowns are set 6 to 8 inches deep in loose soil and only 3 or 4 inches deep in heavy soil.

Figure 1.—This implement is one type used to open furrows for setting asparagus crowns. The blade can be adjusted to make furrows of the proper depth.

Planting Distances

Planting distances are best determined by the grower after considering such factors as whether white (blanched) or green asparagus is to be grown, the type of cultivation to be practiced, the section of the country, soil conditions, and the size of the planting.

Green asparagus does not require as much space between rows as white asparagus. White asparagus is blanched by keeping soil ridged over the crowns. Spacing between rows should be about 7 to 8 feet to provide enough soil to form the ridge. For growing green asparagus the distance between rows varies from 5 to 8 feet. If green asparagus is to be marketed early in the season and blanched asparagus from the same bed is to be marketed later in the season, the rows should be spaced for growing the blanched product. For a small planting in the home garden the planting distances need not be as wide as for commercial plantings.

Spacing between plants for green asparagus must be adjusted to local conditions. The recommended distances in California are 18 to 24 inches in rows 6 to 8 feet apart. In New England the crowns are set 18 to 24 inches from each other in rows 4 to 5 feet apart. In the South, where growth is light, 12-inch spacing in rows 4 to 5 feet apart is recommended. Spacing may vary even within a small section, depending on soil conditions.

A large percentage of small spears will be produced if crowns are set too close together, and too much space between plants reduces yields even though the spears are large.

Setting the Crowns

The very deep planting of crowns formerly in general practice is no longer recommended. In loose, light, organic soil, such as muck, crowns should be planted deeper than in the heavier mineral soils. Most commercial plantings in light soils are made at a depth of about 8 inches. In mineral soils it is doubtful whether it is a good practice to set deeper than 4 inches. Experiments in Massachusetts in mineral soil showed that the loss of plants after setting increased from 11 percent at 4 inches to 34 percent at 8 inches.

Wild asparagus plants are known to do well with no more covering over the crown than resulted from the natural covering of the seed. This indicates that home-garden asparagus can probably be obtained from crowns which grow from seed and are not even transplanted. Where deep planting is practiced it is best to cover the crowns to a depth of only 2 or 3 inches at planting time and to increase the covering by filling in the planting furrows as the shoots develop.

It is good practice to place a small mound of soil in the trench where the crown is to be placed, to set the crown on the peak, and to allow the roots to spread out naturally. Although the careful spreading of the roots is a good practice and should be done in small plantings, generally no attempt is made to spread the roots in large plantings, as it requires considerable time and labor.

Cultivation and Care

Cultivation should begin soon after the crowns are planted and should continue throughout the season at intervals frequent enough to keep down weeds. Any stirring of the soil should be shallow, as serious injury to the roots may result from deep cultivation, especially after the root system has become extensive and the crowns have grown near the surface. Tractor-mounted cultivators are used on large plantations and are satisfactory if properly adjusted. When crowns are planted in deep furrows it is a good practice to fill soil into the furrows at intervals to keep the

growing spears covered. This filling also gives weed control in the rows during the year the crowns are planted. After the first season some hand hoeing is necessary to keep down weeds near the plants. Any working of the soil close to the crowns during the cutting season must be shallow and carefully done to avoid injuring the developing spears. Weed control is very important with a perennial crop like asparagus. A year or two of neglect may result in the soil becoming so foul with seed that weed control may be difficult and expensive.

Calcium cyanamide has been used for the chemical control of weeds in asparagus fields. This chemical kills most broad-leaved weeds, but is not recommended for the control of grasses. The best results are obtained by applying about 100 pounds of finely pulverized calcium cyanamide per acre while the weeds are small. Unless this material is finely pulverized it is not very effective in weed control. Calcium cyanamide supplies both calcium and nitrogen and is frequently used as a source of these elements in fertilizing asparagus. When used as a fertilizer it may be broadcast at the rate of 300 to 500 pounds per acre and worked into the surface soil before growth starts in the spring. Calcium cyanamide may also be used at the end of the cutting season but the application should not exceed 300 to 400 pounds per acre. Injury to the asparagus may result from a heavier application, especially if the weather is dry.

Calcium cyanamide is poisonous. Anyone handling this chemical should wear a dust respirator.

If white, or blanched, asparagus is to be grown, the rows must be ridged up to cover the crowns with several inches of soil. The soil over the crowns must be deep enough for the spears to attain the desired cutting length before reaching the surface. To keep the crowns properly covered it may be necessary to renew the ridges every 2 weeks or oftener.

If green asparagus is to be grown, only a very low ridge or none at all is necessary. The crown of the asparagus plant increases in thickness and thus comes a little nearer the surface each year, so that slight ridging may be necessary when the crowns have come very close to the surface. Too shallow covering of the crowns subjects them to excessive heat during hot weather; this heat causes the tips of the spears to open before they reach the desired length and reduces their market value.

At the end of the cutting season, the asparagus beds should be thoroughly cultivated, the ridges leveled, and the plantation given flat culture for the remainder of the season. The ridges can be plowed down with a turning plow. On large plantations the work of leveling the ridges, like many other field operations, is done with implements especially designed for the job.

Growers are not in complete agreement on what is the best method of handling the tops that grow up after the cutting season. In parts of the North it is believed advisable to leave the tops stand overwinter so they will hold the snow and prevent soil blowing. When tops are left overwinter they are disked into the soil in the spring. Some growers cut off and either remove or burn the tops as soon as the berries begin to mature, because they believe it is important to prevent the scattering of seed. Burning the tops destroys much organic material which might be

profitably returned to the soil, but it destroys diseases and insects if they are present. Asparagus stems are coarse and woody and difficult to work into the soil, and as a general practice it is advisable to collect and burn the tops. However, the tops must not be cut off before they have manufactured and transferred to the fleshy roots enough reserve food to assure a vigorous growth of spears the following year.

Intercropping is often practiced by growers who feel they must have some income from their asparagus beds the first year or two after the crowns are set. Low-growing crops like cabbage, lettuce, beans, and peppers can be grown between rows without serious injury to asparagus. However, most successful growers do not intercrop, and intercropping is not recommended as the best practice. Tall-growing or long-season crops should never be grown with asparagus, as the asparagus may suffer from shading and depleted soil moisture. When intercropping is practiced, it should be discontinued when the asparagus comes into full production.

When and How Long To Harvest

The age at which asparagus plants are ready for harvest varies in different sections of the country, and the length of the cutting season also varies depending on location. Where the growing season is long and relatively cool, as in California, spears may be harvested at an earlier age and the cutting season may be longer than where the growing season is short.

In California and other sections having a long and relatively cool growing season, a short cutting period of 2 or 3 weeks has not injured plants that have had a full year of growth after the crowns were set. The cutting period in the second harvest year may be extended to 6 to 8 weeks in these sections, and up to 12 weeks in following years.

Where growing seasons are short and warm, it is probably a good practice to begin harvesting of spears only after the crowns have had 2 full years of growth after setting, and to limit the first cutting period to 3 to 5 weeks. The cutting period for the fourth and following years is usually 6 to 8 weeks.

When asparagus beds decline in production and yield a large proportion of small spears, the trouble can often be traced back to overcutting during the previous seasons. When such a condition develops it may be beneficial to shorten the cutting season and give particular attention to fertilization and care while the plants make top growth. However, as the beds grow older there is always an increasing proportion of small spears, even in well cared for beds.

Profitable Productive Period

The establishment of a new asparagus plantation involves considerable labor and expense; hence adding a few years to the productive life of the bed may be of considerable economic importance. If properly cared for, a plantation may be expected to produce profitable yields for 10 to 15 years. On very fertile soil and with special care a bed may remain profitable for 20 years or more.

The plantation can be expected to increase in production for several years following the setting of the crowns. After reaching the peak, profitable yields may continue un-

der favorable conditions up to the 12th to 15th year, when the yield is likely to decline. It is generally desirable to renew the plantation after 10 to 12 years. The new bed should be started 2 or 3 years in advance of plowing up the old one, in order to have it yielding profitably before the old bed is abandoned. It may be advisable to renew a part of large plantations each year until the entire acreage has been replaced by new plantings. It is best not to use old asparagus beds for new plantings, but when this is necessary the old land should be planted to some other crop for a year or two before new settings are made.

Climatic conditions, soil texture, soil fertility, planting distances, diseases, insects, and cultural and harvesting methods are all factors which help to determine the number of years an asparagus bed will be productive. Although very light soils are ideal for maximum production for several years, beds in light soils are likely to be shorter lived than those in heavier soils. The asparagus plant is a heavy feeder, and profitable production over a long period requires heavy fertilization. Continued high production requires that the beds be kept free from diseases and insects, for any injury interfering with the proper growth of the tops after the cutting season reduces the amount of reserve materials stored in the fleshy roots and rhizome. Any reduction of the normal reserve food supply will reduce the succeeding crop. Improper cultural practices may interfere with crown development and shorten the life of the bed.

All the factors just discussed and probably many others play a part in limiting the productive life of an asparagus plantation. Special attention to these phases of asparagus culture will be rewarded by increased yields and prolonged life of the beds.

Harvesting the Crop

Three classes of asparagus, based on the color of spears, are marketed. Spears may be entirely green, green with white butts, or entirely white. The greatest demand for fresh asparagus is for the green product, whereas most canning asparagus is white. Nearly all the green asparagus is harvested with a little white on the butt end. Entirely green spears are cut at the surface and do not keep so well as those cut below the surface. Since the underground part of the stem is more woody than the part aboveground, it loses moisture less rapidly than the tender green part and adds to the keeping quality. For home use, asparagus may be snapped or cut aboveground.

Asparagus shoots grow very rapidly and require frequent cutting, especially if the temperature is high. Early in the season the shoots may require cutting only every third day, but as the growth becomes more active it may be necessary to cut twice a day, especially if the asparagus is growing on very light warm soil.

Cutting should be done with a knife made for the purpose. Green asparagus should be 9 to 10 inches in length, and at least half of the length should be aboveground. The underground part should not be too long, as the lower end is fibrous and unpalatable. When cutting, take care to avoid injury to the young spears developing underground. The spears should be cut not closer than 2 inches from the crown, or undeveloped buds on the rhizome may be injured. Knife injury to buds and immature shoots

Figure 2.—The deformed spear on the left is a typical result of cutting-knife injury to young shoots. Growth is slowed down on the injured side of the young shoot, and the spear develops with a pronounced crook. Shoots damaged by cutworms are deformed in the same way.

causes them to develop into crooked spears (fig. 2).

The way to cut marketable spears without injuring the developing shoots is to place the knife near the shoot to be cut and to force the knife straight down to the desired depth before tilting it to make the cut. (See cover illustration.) Many young shoots may be damaged if the knife is forced into the ground at an angle. Asparagus shoots should not be cut aboveground, so that stubs are left. Stubs interfere with harvesting and may injure the hand of the cutter. Spears should be removed from the field as soon as possible after they are cut (fig. 3).

The scarcity and increasing cost of hand labor has led to the mechanization of as many farm operations as possible. Some success has been reported with the use of machines for cutting asparagus in California. It is probable that they will be used increasingly on large plantations there and elsewhere.

Preparation for Market

Asparagus loses edible quality very rapidly after it is harvested, because chemical changes in the spears reduce the amount of sugar and increase the amount of fibrous material. Analysis of the spears at various intervals after cutting shows that the reduction in sugar content and increase in fiber take place most rapidly during the first 24 hours after harvesting. This is particularly true in white asparagus. Although deterioration goes on at all temperatures, it is much slower at temperatures near the freezing point. Because of this rapid loss in quality at high temperatures, it is essential that asparagus be moved from the field, bunched, packed, and placed in a cool atmosphere as soon as possible after it is cut. It is good practice to protect the spears from the sun as much as possible when they are harvested during very warm weather.

If it is necessary to keep asparagus for a time after bunching, the bunches should be stood on end in cold water or on damp moss (fig. 4) and held at a low temperature in some place not exposed to air currents. If placed in water and exposed to warm air currents, the stalks continue to elongate and the changes taking place in the composition of the spears injure their quality. A temperature near freezing reduces these chemical changes to the minimum and preserves the edible qualities.

Figure 3.—This collecting crew is following close behind the cutting crew and removing cut spears from the field before they lose their freshness.

Figure 4.—Bunches of asparagus placed on damp moss in flat to keep them fresh.

Asparagus is generally prepared for market by sorting for grade, trimming, and tying the stalks in bunches weighing 2 to 2½ pounds. Some eastern markets prefer a small bunch and asparagus is either packed in 1-pound bunches for these markets, or the large bunches are divided into smaller ones by the retailer. Field-run and low-grade asparagus is sometimes packed in crates without grading or bunching. In some localities even first-grade asparagus is shipped loose in crates, in spite of the fact that nothing is more important in selling the product than its appearance. Care in grading, bunching, tying, and wrapping should add considerably to the selling price of an asparagus crop.

Figure 5.—This inspector has selected a representative sample from a shipment of asparagus and is inspecting it to determine the grade. Grading procedures vary in different parts of the country and for different markets.

Grading, Washing, Bunching, and Tying

Grading

The United States Department of Agriculture has established market grades (fig. 5) for asparagus. Since these grades are subject to change anyone desiring the latest information should write to the Agricultural Marketing Service, United States Department of Agriculture, Washington 25, D. C.

Asparagus is marketed chiefly under two grades, U. S. No. 1 and U. S. No. 2. Asparagus not meeting the specifications required by these grades is considered as unclassified. The factors used in the grading of asparagus include freshness, length and diameter of the stalk, proportion of the stalk that is green, and the amount of damage due to dirt, diseases, and insect or mechanical injury.

The present specifications classify asparagus on diameter of stalks as follows: Very small, less than 5/16 inch; small, between 5/16 and 8/16 inch; medium, between 8/16 and 11/16 inch; large, between 11/16 and 14/16 inch; and very large, above 14/16 inch. Present standards permit the trimmed bunches to vary in length from 7 to 10½ inches.

Washing, Bunching, and Tying

White asparagus is usually washed. This is done by placing the spears in wire-bottomed trays or baskets and dousing a few times in a vat of water. Unless a considerable amount of soil adheres to the spears, green asparagus should not be washed. If it is necessary to remove soil from the butt end, the butts should be doused in a vat of water, with care not to wet the tips. The stalks should be laid butt downward on some sloping surface to drain before they are bunched. Asparagus keeps best if it is not wet.

Where asparagus is grown in large quantities for commercial purposes it is essential to have a mechanical buncher for holding the stalks while they are being bunched and tied. There are various devices on the market for this purpose (fig. 6). Some of the large plantations are equipped with machinery that cuts the spears to the desired length, but much of the trimming is done by hand. A large number of spears can be trimmed at one operation by placing them in a frame which holds all the tips even, and the extra length of stem can then be cut off with a large knife.

Figure 6.—One type of asparagus-bunching device. Note that the spears have been cut to a uniform length.

Where a small bunching machine is used the spears are usually cut to the right length while the bunch is held in the buncher.

The tightest and most attractive bunches are made by tying near each end, as shown in figure 4. A single tie near the center permits slipping and makes an unattractive bunch. Raffia, twine, and tying tape are the materials most commonly used for tying the bunches. Tying tape is the most expensive, but it is recommended. Raffia does not have the neat appearance of tape, and twine is likely to cut the spears if tied very tight. Tape is available in various colors, and sometimes grades of asparagus are indicated by the color of tape. Only good grades of tape having fast colors should be used, as any discoloring of the spears from dye may lower the market value.

There is some shrinkage in asparagus after it is bunched, especially if it has a high water content before bunching. Bunches should be tied as tight as possible without injuring the stalks, in order to prevent loose bunches after shrinkage.

Many growers and shippers market an attractive product by wrapping bunches in parchment paper so that only the tips of the spears extend above the paper. The wrapper usually bears the name and address of the grower or shipper. This is a good way to advertise a high-quality product.

Packing and Shipping

Shipping crates of different types are used in the various sections where asparagus is grown. The most commonly used crate is pyramidal in form (fig. 7) and has two compartments each holding six 2- to 2½-pound bunches. A typical pyramidal crate used in California is 11 inches deep, 9 inches wide at the top and 11 inches wide at the bottom, and 18 inches long. A similar crate is used in Georgia and the Carolinas. The tendency in most States is toward this type of crate, but the dimensions may vary in different States. The pyramidal crate makes an excellent shipping container, as the shape conforms to the taper of the bunches and prevents their shifting about in shipment. The bottoms of the crates are usually lined with paper, which is covered with a layer of damp moss. The butts of the bunches are placed on the moss. When packed in this way and kept

Figure 7.—Asparagus packed in pyramidal crates.

at a temperature just above freezing, asparagus can be shipped a long distance and will keep for several days without serious loss in quality.

In the early part of the cutting season when the yield is small and the product is sold in nearby markets, asparagus is shipped either by express or by motortrucks without refrigeration. After the cutting becomes heavy and carlot shipments begin, most of the asparagus is shipped under refrigeration.

Insect Pests [1]

Asparagus Beetle

The asparagus beetle (*Crioceris asparagi* (L.)) is the insect causing the most widespread damage to the crop. The insect overwinters in the adult, or beetle, stage in rubbish or other debris around the field. Adults emerge early in the spring and damage market-size asparagus by feeding and depositing eggs on the aboveground parts of the shoots. Young plantings which are not ready for harvest are also subject to severe injury early in the year.

Eggs are laid on mature plants later in the season. After hatching from the eggs the small, dark-colored larvae feed with the adults upon the foliage, and in heavy infestations the two forms of the insect defoliate large areas in a short time. It requires 10 days to 2 weeks for the larvae to complete their development; they then drop to the ground and form cocoons in which to transform to the pupal stage. After about a week or 10 days in the pupal stage the insects emerge as adults.

There may be one or more generations during a season, depending on the climate. Asparagus beetles do not thrive during the hot summer months, and most of the damage is inflicted in the spring and early summer.

The beetles and the larvae of the asparagus beetle are controlled at any stage in the growth of the crop by applying a dust mixture containing 0.75 percent of rotenone as soon as the insects are noticed on the plants. All parts of the infested plants should be covered

[1] Prepared in the Entomology Research Branch.

thoroughly with the dust. Applications should be repeated as often as required to control the insect. Ordinarily not more than two applications, about a week apart, are needed for satisfactory control.

Cutworms

Cutworms frequently cut off asparagus shoots underground, and also cause trouble by feeding on the tips of the shoots as they appear above the ground. Shoots damaged by the feeding develop into crooked spears (fig. 2). These pests can be controlled readily by the use of the following poisoned bait: 1 peck (or 5 pounds) of dry bran, ¼ pound of sodium fluosilicate or paris green, and 3 or 4 quarts of water; or, in large quantities, 25 pounds of dry bran and 1 pound of sodium fluosilicate or paris green with enough water to moisten.

To prepare the bait: (1) Thoroughly mix the poison with the bran. This is important. Each particle of bran must carry a little poison to get a good kill. When making small quantities, mix the bait in a bucket with a paddle, adding the poison slowly and stirring the bran at the same time. When making large quantities, mix the poison with the bran on some flat, smooth surface; use a shovel and rake in much the same way as in mixing concrete. (2) Add the water to the mixture of bran and poison, stirring slowly all the time. Large quantities of water added at one time will wash the poison from the bran and the result will be an uneven mixture. Add only enough liquid to make a crumbly mass.

It is a good plan to set aside a little of the mixture of dry bran and poison so that if too much water is used this dry reserve can be added to bring the mixture up to the proper consistency. Large quantities can be made up in galvanized-iron or wooden washtubs and small quantities in buckets or similar containers.

The poisoned bait may be either broadcast with a mechanical spreader or scattered by hand along the rows or about the base of the plants. This should be done late in the evening so the bait will not dry out before the worms start their daily feeding. Since many kinds of cutworms overwinter in the ground and start feeding as soon as the weather becomes favorable in the spring, it is a good plan to broadcast the poisoned bait over the field before the asparagus shoots begin to appear above ground.

Ten to fifteen pounds of the wet bait per acre is enough for one application. Where the bait is applied directly to the rows or hills a smaller quantity is sufficient. It may require two or three applications at 2-day intervals to rid the field of the pests.

A stomach poison for an insect is poisonous also to animals and man. Keep the poison and poisoned-bran bait away from farm animals. Destroy all bait left over, and thoroughly clean all vessels and utensils used.

Garden Centipedes

In certain parts of California a pest known as the garden centipede (*Scutigerella immaculata* (Newp.)) has become at times very destructive to large areas of asparagus. This centipede feeds below the surface of the ground on the succulent shoots of the asparagus plant and is most successfully combated by flooding. The ground should be covered with water to a depth of 1 to 3 feet for a period of 3 weeks during the latter part of December and the first part of Jan-

uary. Many soil fumigants have been tried in an effort to control this centipede, but no satisfactory chemical method of control has been developed.

Asparagus Diseases[2]

Asparagus Rust

Asparagus is subject to a number of diseases, but asparagus rust, caused by the fungus *Puccinia asparagi*, is the only one of great economic importance. Rust was first reported from New Jersey, Delaware, Long Island, N. Y., and New England about 50 years ago. It later appeared in practically all sections where asparagus is grown. The presence of the disease is closely related to environmental conditions. Rust spores are dependent on moisture for germination, and the disease is much more destructive in areas of high humidity and heavy rainfall than in low-moisture areas.

The disease is commonly first observed as numerous small reddish-yellow spots on the main stems near the ground and on the very slender branches of the stalks which grow up after the cutting season. The red spots are pustules that contain seedlike bodies, or spores, that reproduce the fungus. These pustules burst and liberate great numbers of rust spores, which have the appearance of reddish or rust-colored powder. By close examination of the stems the pustules may be found before they become numerous enough to attract attention. The spores liberated from the pustules are rapidly scattered by the wind; if sufficient moisture is present they may infect all the plants in the field.

Asparagus rust causes the tiny needlelike branches of the stems to fall and the affected plants present a naked appearance, as shown in figure 8, *A*. When the attack is severe the entire field may ultimately become brown and appear dead, as shown in figure 9. The effect of rust is not directly evident on the marketed product, because damage is done to top growth after the harvest season. Injury to the tops slows the manufacture of food and the plants are either killed or

Figure 8.—*A*, Seedlings of Argenteuil asparagus, showing some resistance to rust; *B*, the highly rust-resistant Washington asparagus.

[2] Originally prepared by W. W. Gilbert, formerly senior pathologist, and revised by S. P. Doolittle, senior pathologist, Horticultural Crops Research Branch.

Figure 9.—An old asparagus field killed out by rust (foreground). The new field of the Reading Giant variety on the left was grown as a breeding field for rust-resistance work.

go into the winter in a starved condition. As a result the succeeding crop suffers a reduction in the size and number of shoots produced.

The most effective way to control asparagus rust is to plant varieties known to be resistant. The most rust-resistant variety of asparagus in cultivation is Martha Washington. Mary Washington, although slightly less resistant than Martha Washington, is sufficiently resistant for planting except where rust attacks are severe. The earliness and large size of Mary Washington make it especially desirable for general planting. When first introduced, the two Washington varieties generally showed a high resistance to rust, but of late years there have been occasional losses from rust on varieties reported to be either Mary Washington or Martha Washington. It is possible that high rust resistance may not have been maintained in some stocks of these varieties, or possibly there are strains of the rust fungus to which they are not highly resistant. When buying either of the Washington varieties, the grower should obtain information regarding the previous performance of the stock with respect to rust resistance.

Because rust has been reported on even the rust-resistant varieties, growers should take measures to protect all plantings by eliminating sources of rust infection. The two main sources of infection are wild asparagus plants growing in the vicinity of cultivated beds, and seedlings that are allowed to grow up in the field before the cutting season is over.

Wild asparagus carries the rust overwinter, and in the spring spores are liberated to infect the field. Seedlings which are allowed to grow up in the field during the cutting season also give the disease organisms an opportunity to develop and to liberate great numbers of spores. These sources of infection can be eliminated by digging up and burning all wild plants, and preventing the top growth of shoots in the field until after the cutting season.

New beds should be planted with rust-resistant strains and located as far as possible from the old beds. The new plantings are further protected if they are located so that prevailing winds will not blow from the direction of established plantings. In the fall the tops should be removed from the 1-year-old beds that are to be cut the next year.

The removal of the tops from mature beds in the fall is not considered important as a rust-control measure. Repeated tests have shown that the spring stage of rust does not occur in the fields where the tops are left overwinter and disked into the soil in the spring, provided that tops are not allowed to start growth until the cutting season is over.

Spraying and dusting with fungicides have met with varied success in different sections. Bordeaux mixture with a resin-fish oil or other sticker was once used in the East, but the treatment was not successful and has been discontinued. In California the best re-

sults with fungicides have been obtained with finely divided sulfur dust applied on plants wet with dew. Growers usually make the first application at 25 to 30 pounds per acre about 3 weeks after the cutting season. A similar application about a month later is usually sufficient to hold rust in check. More than two applications are sometimes made on newly planted beds or in beds where cutting stops early in the season.

Stickers and such poisons as bordeaux mixture must be thoroughly washed from the spears to be used as food.

Fusarium Wilt

Asparagus shoots affected with fusarium wilt are sometimes wilted and stunted, and they may show a brown discoloration of their surface. These stalks are usually unfit for market, and yields occasionally are considerably reduced by this wilt.

Wilt, which is caused by a fungus (*Fusarium* sp.) occurring in the soil, has been reported from most asparagus-producing sections of the United States. Losses in individual plantings occasionally are severe but this disease does not occur so commonly as does rust. The only control measures are to avoid further plantings on infested soil and to take care in procuring healthy planting stock. New plantings should be kept as far as possible from infected old beds.

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